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EARTH PENETRATOR WEAPON SYSTEM DESIGN

W. J. PATTERSON AND N. A. LAPETINA; SANDIA NATIONAL LABORATORIES

INTRODUCTION

MAJOR EPW SUBSYSTEMS

EPW SYSTEM DESIGN RATIONALE

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WEIGHT REDUCTION



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EARTH PENETRATOR WEAPON SYSTEM DESIGN

EPW SYSTEM DESIGN RATIONALE

REQUIRED INFORMATION FOR FIRST DESIGN ITERATION

EPW CASE DESIGN

TERRADYNAMIC CONSIDERATIONS

TARGET CHARACTERISTICS THAT IMPACT EPW SURVIVABILITY

NUCLEAR SYSTEM LOCATIONS

WARHEAD ELECTRICAL SYSTEM CONCERNS



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EARTH PENETRATOR WEAPON SYSTEM DESIGN

EPW CASE DESIGN CONSIDERATIONS

INTERNAL CASE SIZING

DIMENSIONS DEPENDENT ON NUCLEAR SYSTEM AND WARHEAD
ELECTRICAL SYSTEM (WES) DESIGNS

EXTERNAL CASE SIZING

DIMENSIONS OPTIMIZED FOR MINIMUM LENGTH, DIAMETER
AND WEIGHT BUT MUST CONSIDER:

TERRADYNAMIC STABILITY

WORST CASE STRUCTURAL LOADING

DELIVERY SYSTEM ACHIEVABLE IMPACT CONDITIONS

CASE MATERIAL

HIGH STRENGTH STEEL WITH HIGH FRACTURE TOUGHNESS



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EARTH PENETRATOR WEAPON SYSTEM DESIGN

TERRADYNAMIC CONSIDERATIONS

EPW STABILITY STRONGLY INFLUENCED BY:

EPW STRUCTURAL LOADING PRIMARILY INFLUENCED BY:

NOSE SHAPE (SHARPER NOSED EPW RESULTS IN LOWER LOADS)

WEIGHT TO CROSS SECTIONAL RATIO, W/A

STABILITY AND STRUCTURAL LOADING ALSO STRONGLY DEPENDENT ON:

TARGET PROPERTIES

SURFACE FEATURES

IMPACT CONDITIONS



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EARTH PENETRATOR WEAPON SYSTEM DESIGN

TARGET CHARACTERISTICS THAT IMPACT EPW SURVIVABILITY

HARDNESS

CONFINED SHEAR STRENGTH (PRESSURE DEPENDENT)

VOLUMETRIC COMPRESSIBILITY

DENSITY

MOISTURE CONTENT

IRREGULARITIES (INDUCE LARGE LATERAL LOADS)

BUILDINGS

RUBBLE

BOULDERS

TREES

TARGET NON HOMOGENEITY



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EARTH PENETRATOR WEAPON SYSTEM DESIGN

WARHEAD ELECTRICAL SYSTEM DRIVERS

NUCLEAR SAFETY

DELIVERY SYSTEM INTERFACE

RUGGED, RELIABLE, FLEXIBLE PACKAGING

MULTIPLE FUZING OPTIONS

AIRBURST, CONTACT, AFTER PENETRATION, SYNCHRONOUS



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David A. ...

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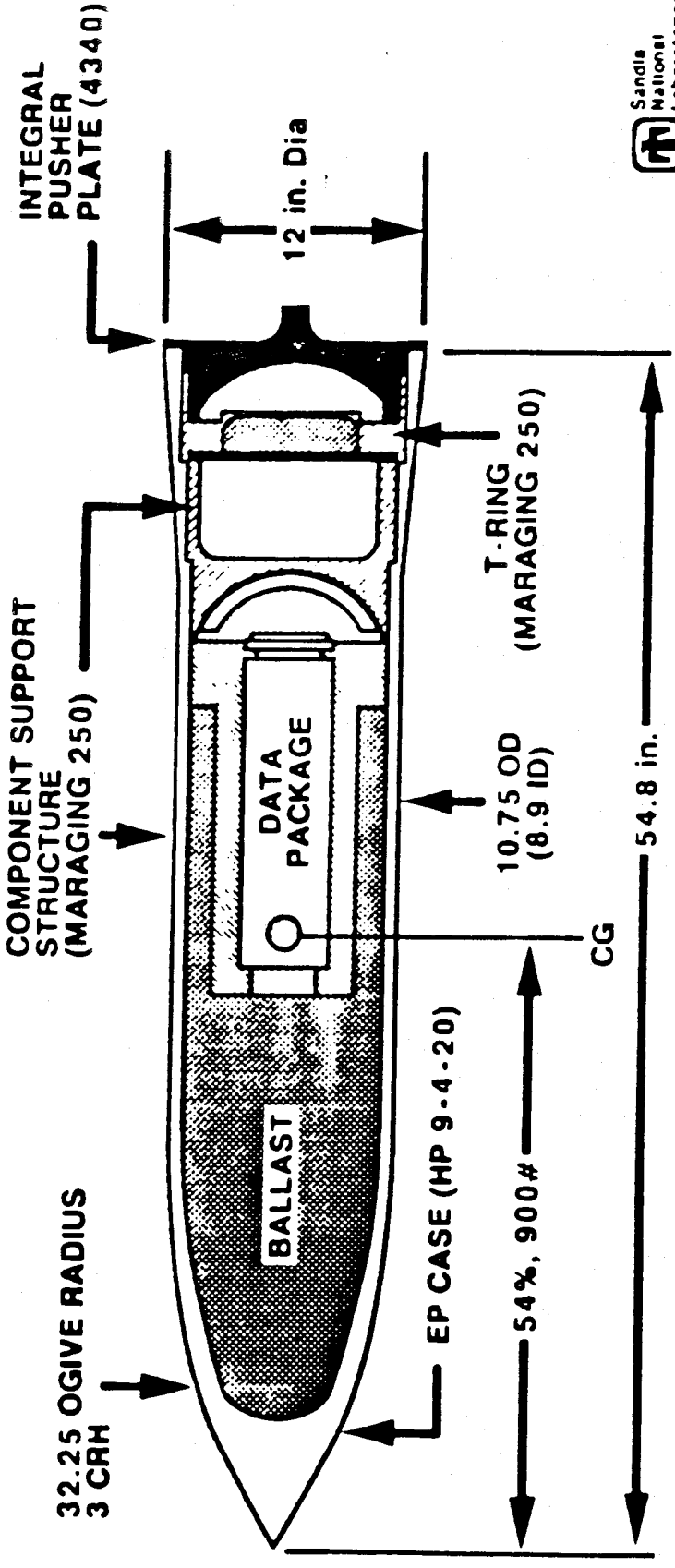
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86TH5000.08

PROPERTIES

- L/D = 5.1
- W/A = 9.9
- Wt = 900 lb
- CG = 29.6 in.
- PITCH = $2.1 \times 10^5 \text{ lb} \cdot \text{in.}^2$

EARTH PENETRATOR TEST DEVICE



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National
Laboratories

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EARTH PENETRATOR WEAPON SYSTEM DESIGN

EPW CASE WEIGHT REDUCTION METHODS

REDUCE WEIGHT OF BASELINE STEEL CASE BY RESTRICTING:

DELIVERY CONDITIONS

TARGET TYPES

USE LIGHTER WEIGHT MATERIALS

TITANIUM

HYBRID COMPOSITE (e.g. METAL PLUS GRAPHITE/RESIN)

BI-METALIC (e.g. STEEL + TITANIUM)



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b. Conference paper: Title of conference AIAA Future System & Ballistic Missile Technology Workshop Date of conference 3/22-25/88

Location of conference Norton AFB, CA Sponsoring organization BMO/AIAA

Other (Specify) _____

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HB-III Helicopter Air Drop

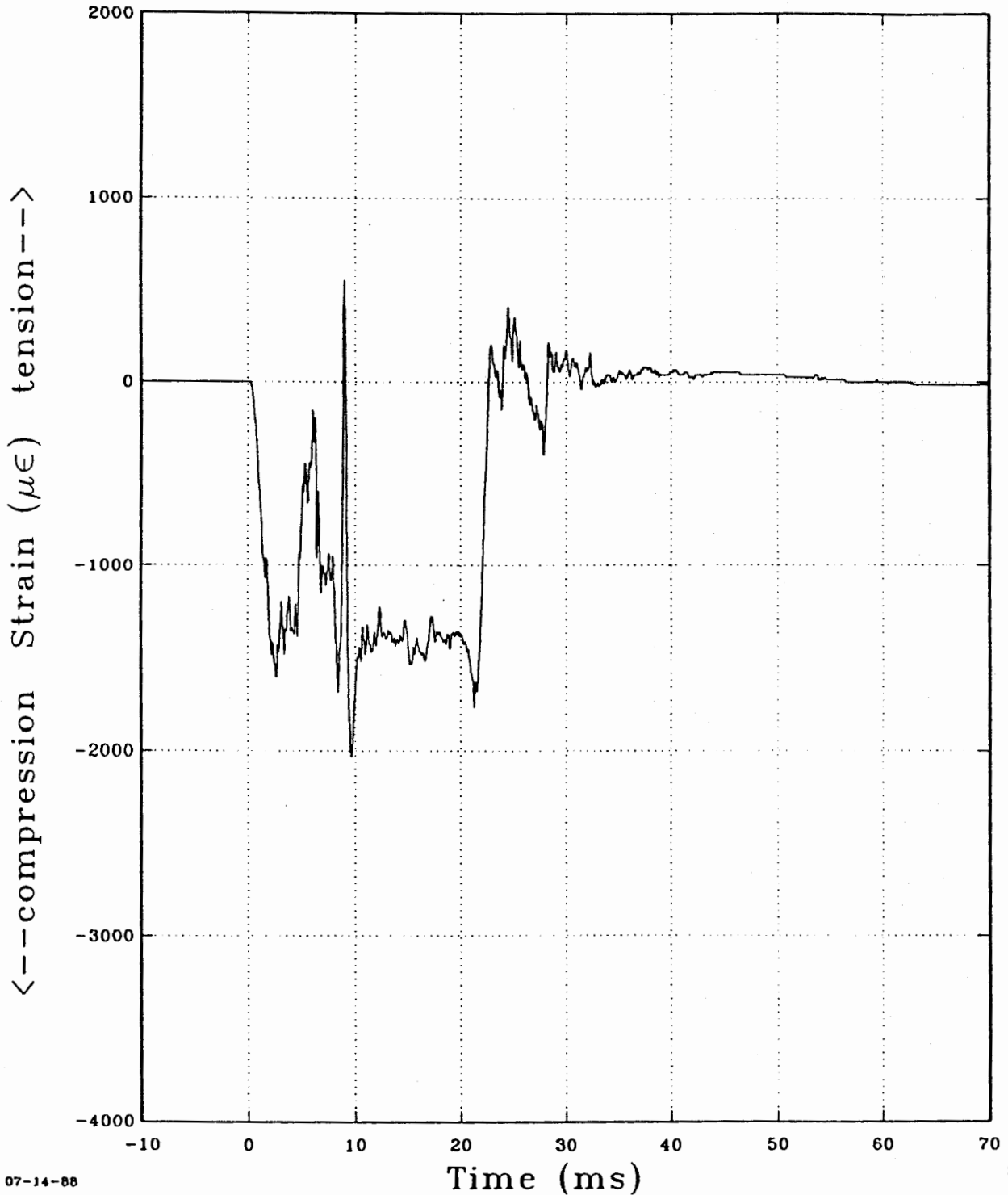
Axial Strain

(0 degrees + 180 degrees) / 2

Analog LPF: 4800 Hz
Digital LPF: none

Test Date
02-12-88

W61-3
SSP-85



07-14-88

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HB-III Helicopter Air Drop

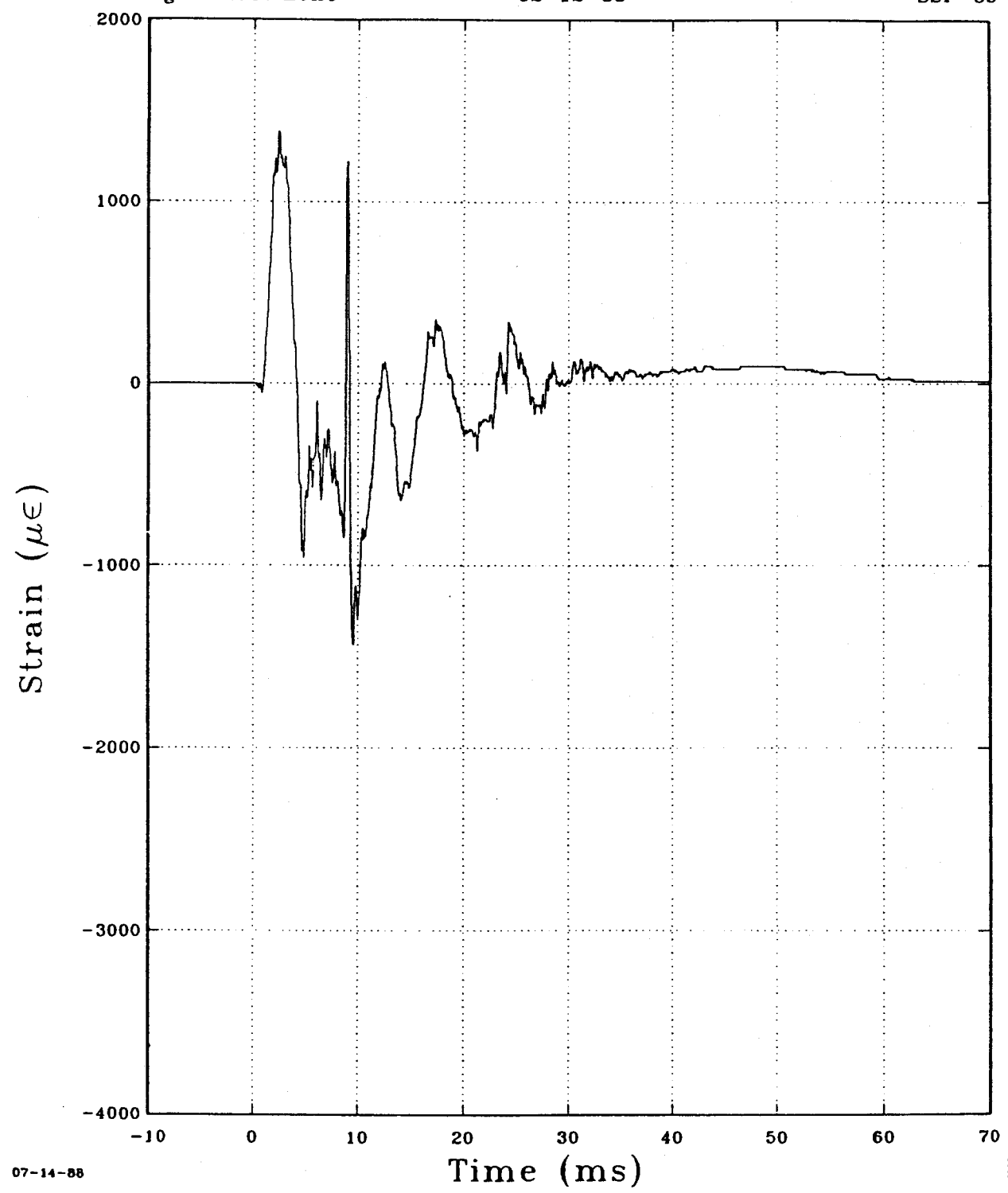
Bending Strain

(0 degrees - 180 degrees) / 2

Analog LPF: 4800 Hz
Digital LPF: none

Test Date
02-12-88

W61-3
SSP-85



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ADAM

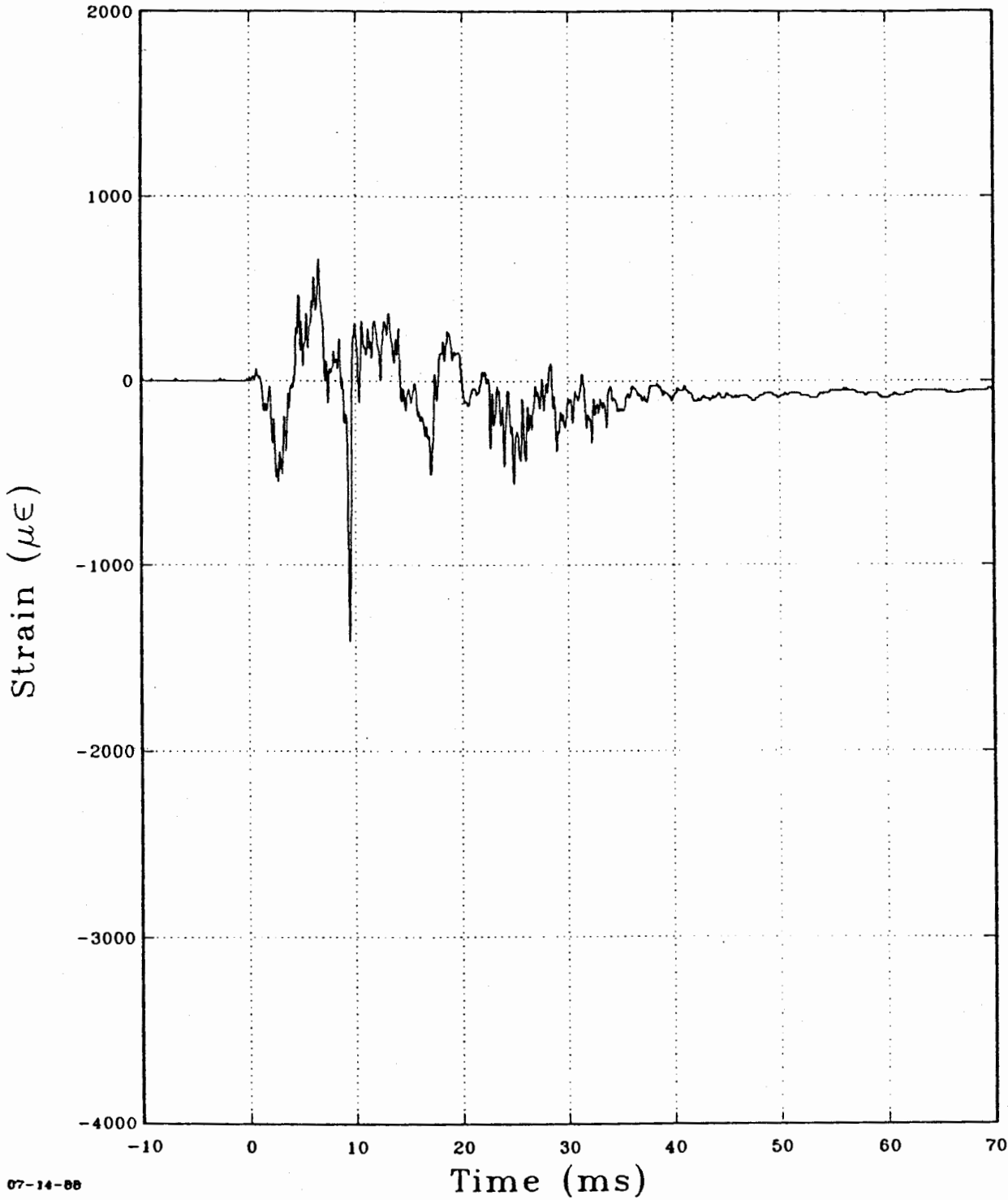
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HB-III Helicopter Air Drop
Bending Strain
(90 degrees - 270 degrees) / 2

Analog LPF: 4800 Hz
Digital LPF: none

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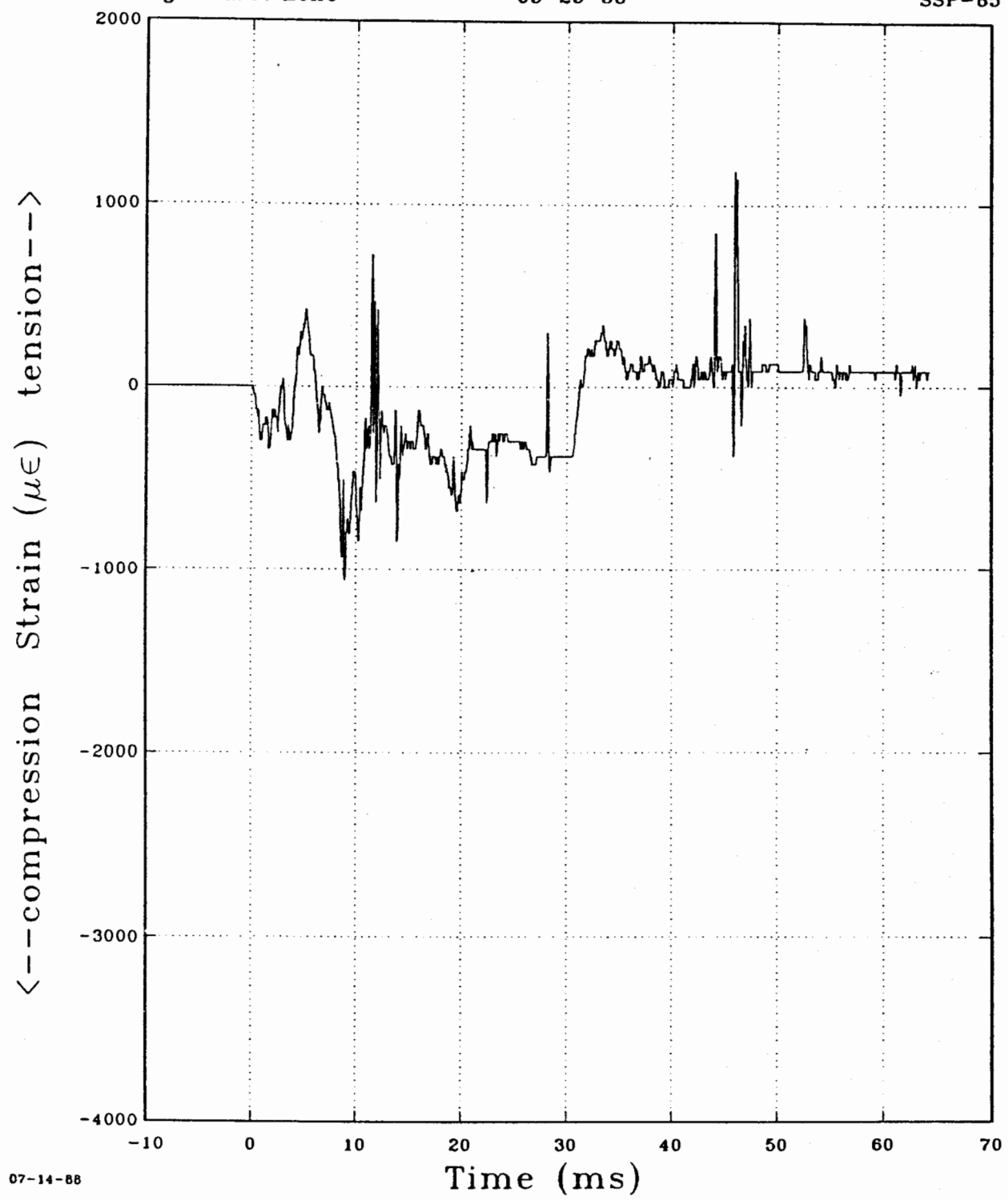
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HB-IV Helicopter Air Drop Strain at 0 Degrees

Analog LPF: 4800 Hz
Digital LPF: none

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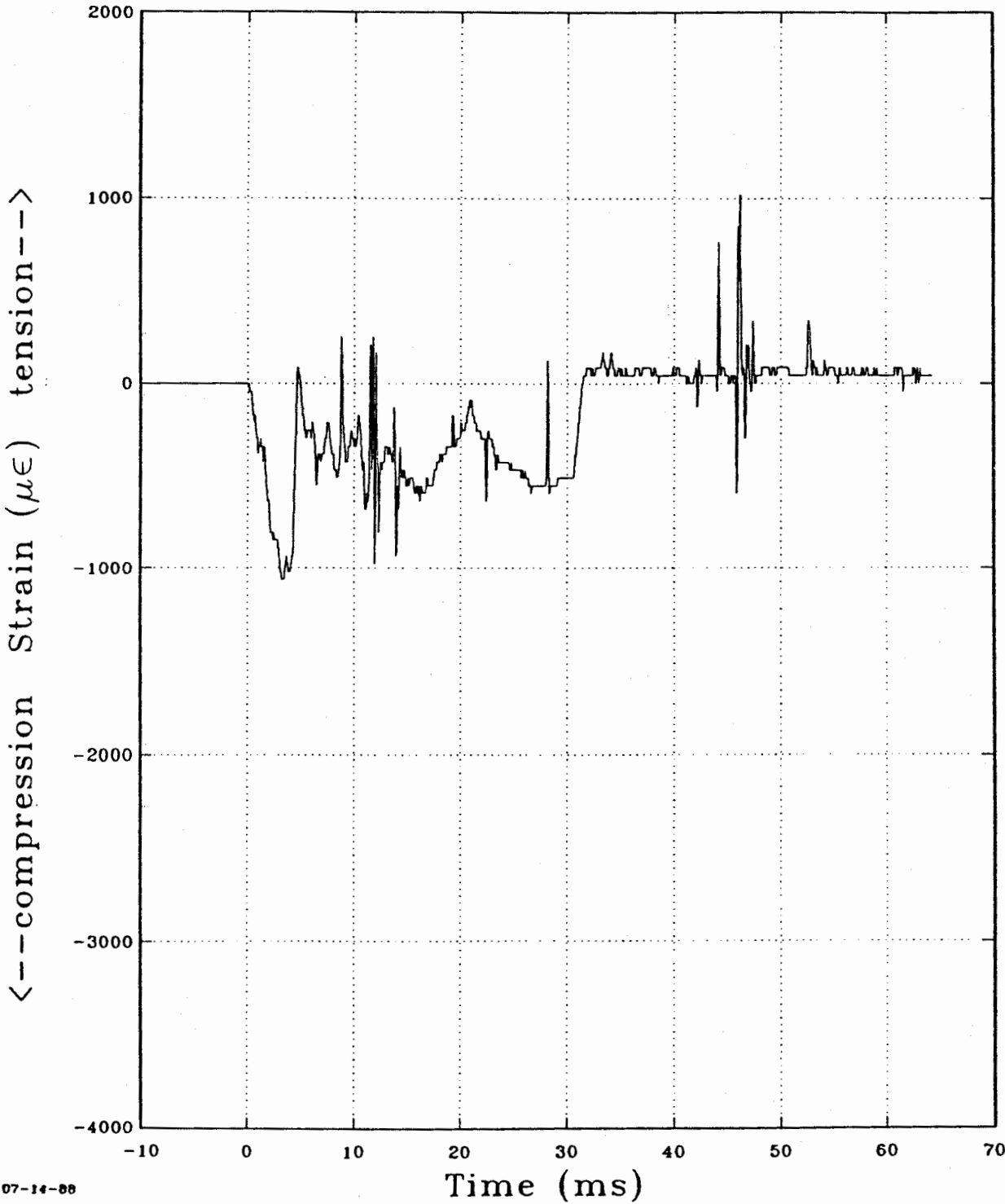
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HB-IV Helicopter Air Drop Strain at 120 Degrees

Analog LPF: 4800 Hz
Digital LPF: none

Test Date
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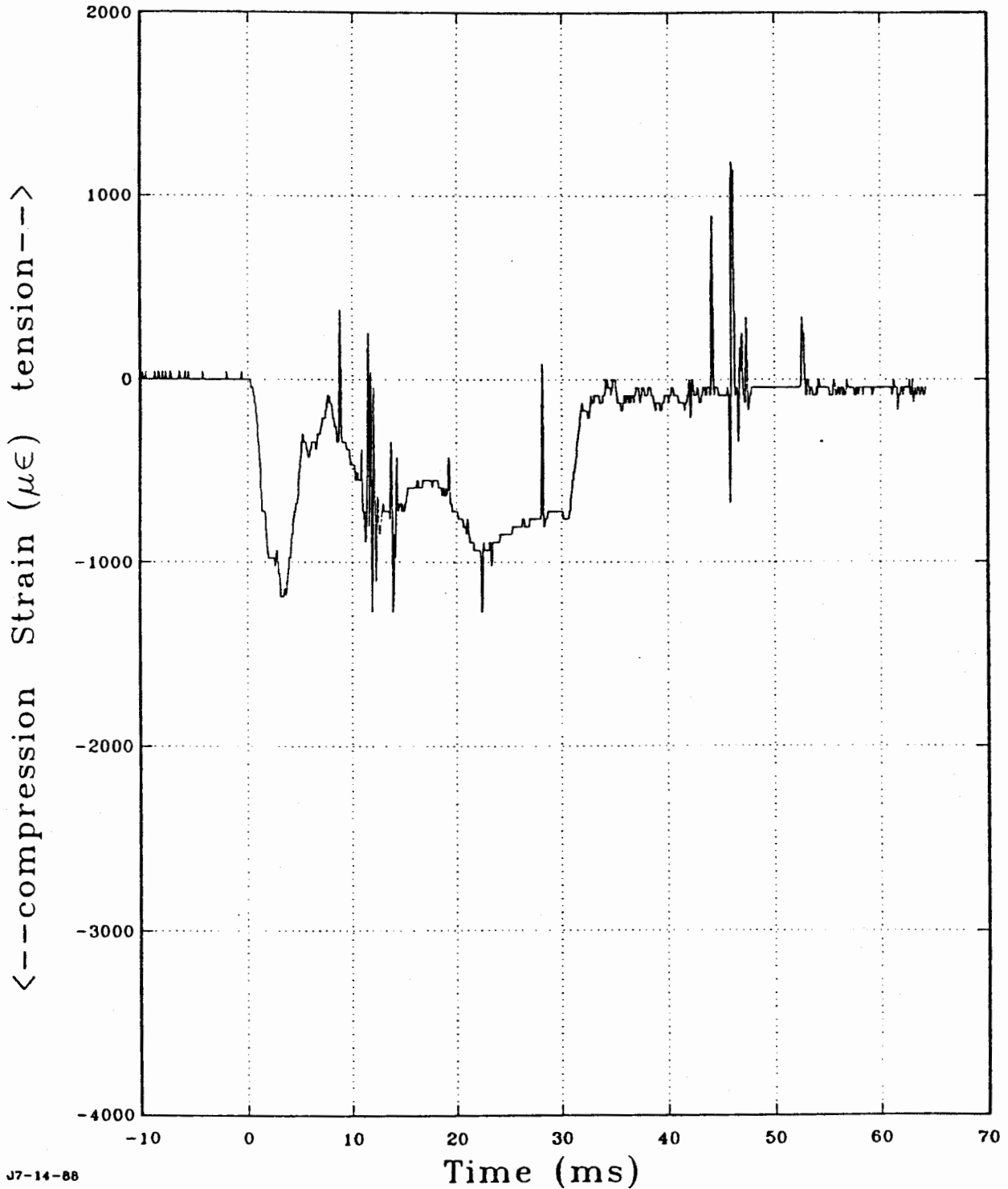
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HB-IV Helicopter Air Drop Strain at 240 Degrees

Analog LPF: 4800 Hz
Digital LPF: none

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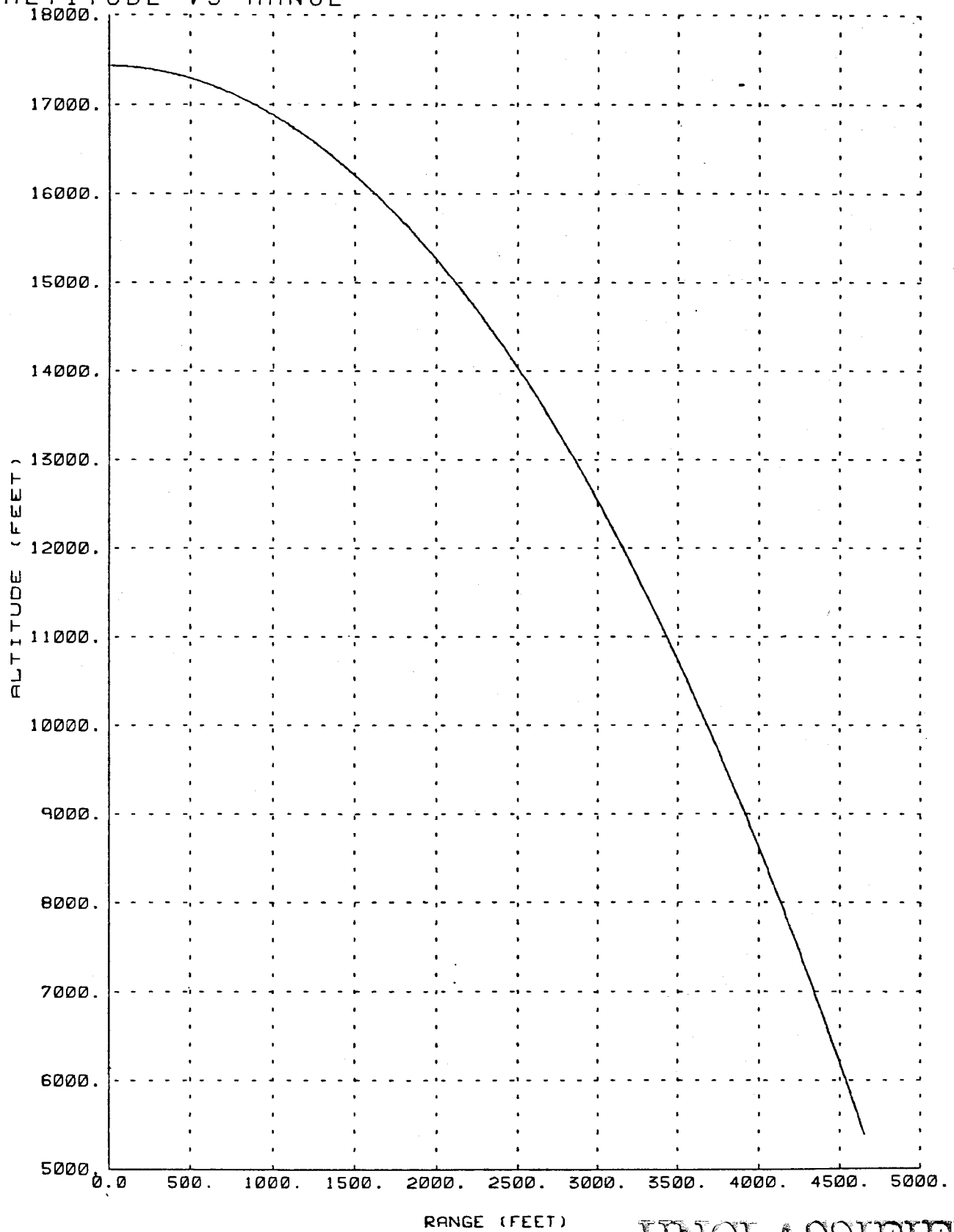
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ALTITUDE VS RANGE

OPTICAL



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APPENDIX F

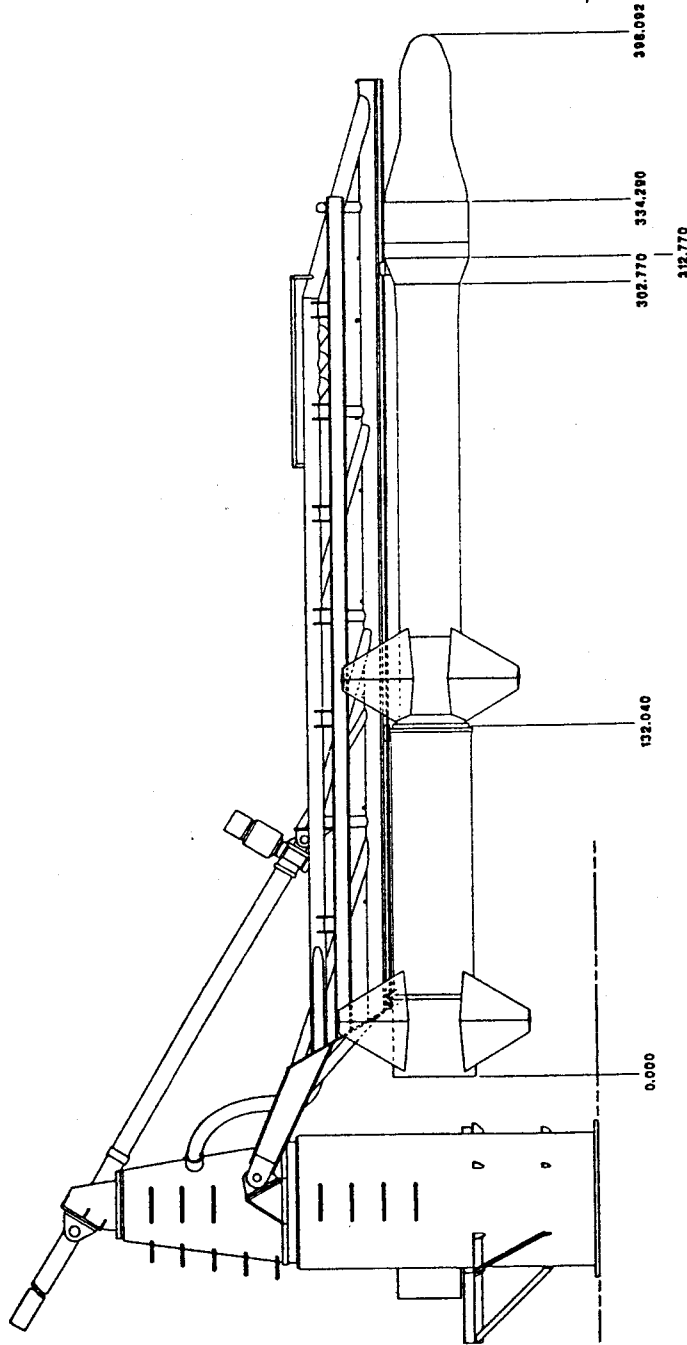
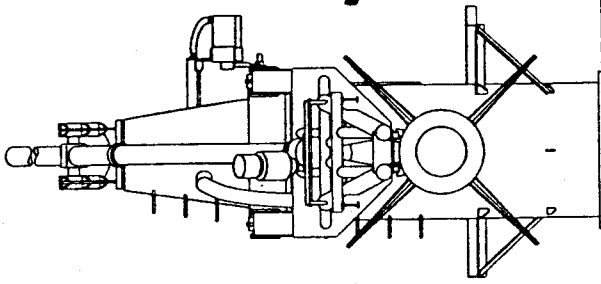
Mk-11 Rocket Test Specifications

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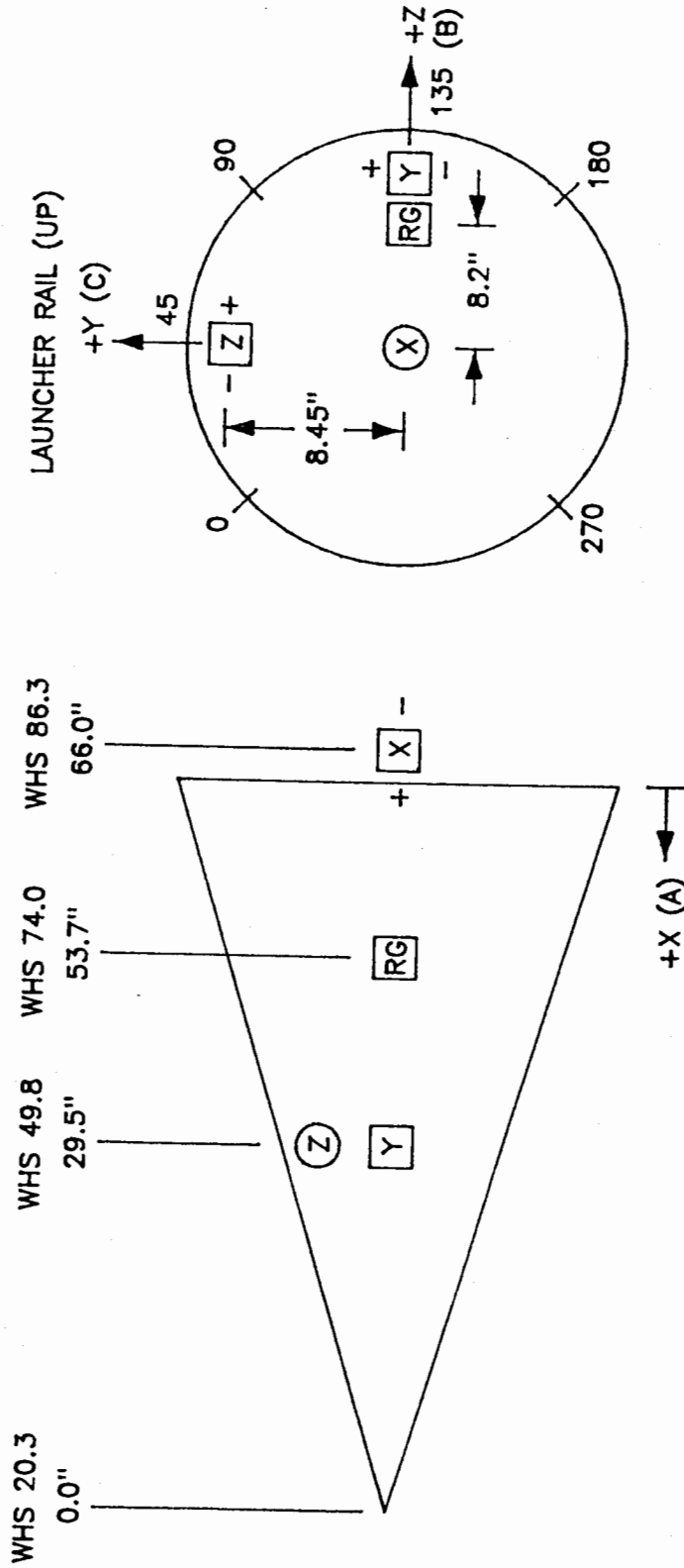


TALOS / HONEST JOHN / MK11 APPLICATION

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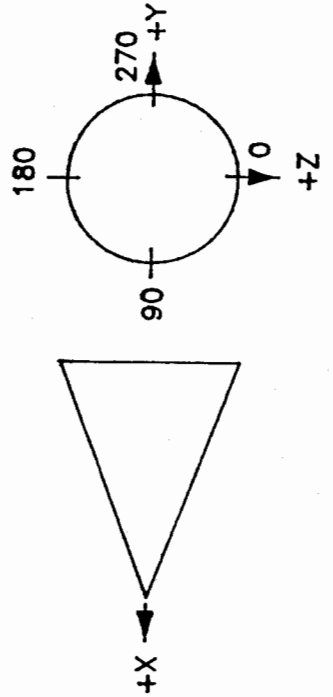
TRANSDUCER LOCATIONS AND SIGN CONVENTIONS



NOTE: ALL ROTATIONS (A,B,C) ARE POSITIVE IN THE CLOCKWISE DIRECTION LOOKING IN THE POSITIVE (X,Y,Z) AXIS

MASS PROPERTIES

- WT: 1314.2 LBS
- XBAR: 30.37 IN (WHS 50.67)
- YBAR: .0008 IN
- ZBAR: .0025 IN
- RBAR: .0026 IN
- PAT: .130 DEG
- IXX: 38575 IN-LB2
- IYY: 466847 LB-IN2
- IZZ: 468524 LB-IN2
- IXY: 802.7 LB-IN2
- IXZ: 546.5 LB-IN2
- IYZ: -721.9 LB-IN2



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MK11 ROCKET TEST SPECIFICATIONS

	<u>FIRST STAGE</u>	<u>SECOND STAGE</u>
MOTOR TYPE	TALOS	IMPROVED HONEST JOHN
LENGTH (IN)	133	164.5
DIAMETER (IN)	31	24.5
WEIGHT (LBS) FULL	4278	2890
EMPTY	1475	1227
SPEC IMPULSE (LBF-SEC/LBM)	213	215
BURN TIME (SEC)	5.75	3.4
AVERAGE THRUST (LBF)	109800	100000

TOTAL SYSTEM WEIGHT AT LAUNCH: 9353.5 LBS (MEASURED)

TOTAL SYSTEM LENGTH AT LAUNCH: 398 IN = 33.2 FT

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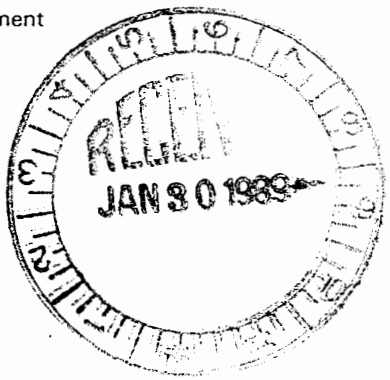
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